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(57) Abstract

A water spray system (figure 1) for an aircraft has a plurality of spray outlet nozzles (6', 6'', 6''') which are distributed throughout the passenger cabin of the aircraft and are coupled to a water storage vessel (1). A pyrotechnic gas source (5) is used to pressurize the water stored in vessel (1). The system may comprise a plurality of sub-systems each being associated with a respective section of the aircraft cabin and being operable independently of the others. The pyrotechnic gas source (5) can be actuated by a control signal (I_O) produced by a control unit (8) in response to different input signals, and the or each storage vessel is fitted with an exhaust valve (11) to vent the stored water if the system is actuated inadvertently. The spray outlet nozzles may operate in different modes and may be directed to increase the residence time of water droplets in an upper part U of the cabin. The system may be coupled to an external supply system by means of a remotely launched projectile.

IMPROVEMENTS RELATING TO WATER SPRAY SYSTEMS

BACKGROUND OF THE INVENTION

This invention relates to water spray systems, and particularly, though not exclusively, to water spray systems for aircraft.

In the event of a fire in the cabin of an aircraft, known water spray systems discharge a fine spray into the cabin via an array of spray outlet nozzles. The water may be carried on the aircraft (on-board system) or delivered from a fire appliance or other external source.

The water droplets forming the spray have several beneficial effects. They provide an infra-red radiation barrier protecting passengers and crew, improve visibility within the cabin and absorb toxic gases which congregate in the upper zone of the cabin, enabling passengers to breathe more easily. The spray also has a cooling effect on the gas cloud near the roof of the cabin, slowing its progagation and reducing the risk of flash-over ignition. Also, the spray wets combustible material (furnishings etc.) delaying their ignition, and has a cooling effect on the interior surface of the aircraft wall.

Notwithstanding these beneficial effects, existing water spray systems have serious drawbacks.

For instance, in the event that the aircraft sustains severe damage (during a crash landing, for example) the fuselage could separate into discrete sections, and this could compromise the operational integrity of the entire water spray system.

Furthermore, known on-board water spray systems operate at relatively low pressure, whereas water is supplied by a fire appliance (or other external source) at a much higher pressure. This leads to a requirement for separate on-board and external supply systems with an increased overall weight; but coupling between the two systems has not been successfully achieved. Also, such systems may require a relatively large quantity of water, exacerbating the weight problem.

It is an object of the present invention to provide improved water spray systems which substantially alleviate the afore-mentioned problems and/or which require a substantially reduced quantity of water.

SUMMARY OF THE INVENTION

According to first aspect of the invention, there is

provided a water spray system comprising a water storage vessel, at least one spray outlet nozzle connected to the water storage vessel and a pyrotechnic gas source for pressurizing the water storage vessel enabling water in the vessel to be discharged via the at least one spray outlet nozzle.

The pyrotechnic gas source may comprise a pyrotechnic material (e.g. an alkali metal azide, such as sodium azide) and an oxidizing agent (e.g. an alkali metal chlorate or perchlorate).

According to a second aspect of the invention, there is provided a water spray system comprising a water storage vessel, at least one spray outlet nozzle connected to the water storage vessel, means responsive to a control signal for pressurizing the water storage vessel enabling water stored in the vessel to be discharged via the at least one spray outlet nozzle and processing means for generating the control signal in response to input signals derived from different respective sources.

According to a third aspect of the invention, there is provided a water spray system comprising a water storage vessel, at least one spray outlet nozzle connected to the water storage vessel, means for pressurizing the water

storage vessel enabling water stored in the vessel to be discharged via the at least one spray outlet nozzle and an exhaust valve operable to vent the water stored in the vessel.

According to a fourth aspect of the invention, there is provided a water spray system comprising a water storage vessel, at least one spray outlet nozzle connected to the water storage vessel and means for pressurizing the water storage vessel enabling water in the vessel to be discharged via the at least one spray outlet nozzle to a respective zone and wherein the at least one spray outlet nozzle so directs the spray as to enhance the residence time of water droplets in the spray in an upper region of a zone. The at least one spray outlet nozzle may be directed upwardly and/or laterally. By this means, less water is required to achieve the desired effect.

According to a fifth aspect of the invention, there is provided a water spray system comprising a plurality of water spray sub-systems each comprising a water storage vessel, at least one spray outlet nozzle connected to the water storage vessel and means for pressurizing the water storage vessel enabling water in the vessel to be discharged via the at least one spray outlet nozzle, wherein each sub-system operates independently of the

others to supply spray to a respective zone.

The water spray system has particular, though not exclusive, application to aircraft, each said zone being a respective section of the aircraft cabin.

According to a sixth aspect of the invention there is provided a water spray system comprising a water storage vessel, at least one spray outlet nozzle connected to the water storage vessel and means for pressurizing the water storage vessel enabling water stored in the vessel to be discharged via the at least one spray outlet nozzle to a zone, wherein the at least one spray outlet nozzle is operable in each of three distinct modes; a sealed mode, enabling pressure testing to be carried out up to a first predetermined pressure, a low flow mode operable in response to a water supply pressure exceeding the first predetermined pressure, but less than a second predetermined pressure, and a high flow mode operable in response to a water supply pressure exceeding the second predetermined pressure.

The invention also relates to a spray outlet nozzle defined in accordance with the sixth aspect of the invention.

According to a further aspect of the invention, there is provided a method for connecting a water spray system having a water storage vessel to an external water supply system, including the steps of penetrating a wall of the water storage vessel whereby to simultaneously connect the interior of the vessel to the external supply system via the penetration hole formed in the supply vessel.

The wall of the water supply vessel may be penetrated by a remotely launched penetration device which may be coupled to the external supply system by means of a flexible hose.

DESCRIPTION OF THE DRAWINGS

Embodiments of the invention are now described, by way of example only, with reference to the accompanying drawings in which:

Figure 1 is a schematic representation of a water spray sub-system in accordance with one aspect of the invention;

Figure 2 shows a longitudinal cross-sectional view through an active vent in the open and closed conditions thereof;

Figure 3 illustrates the manner by which an external

water supply system may be coupled to the sub-system illustrated in Figure 1;

Figure 4 shows a longitudinal cross-sectional view through a three-mode spray outlet nozzle; and

Figure 5 shows a transverse cross-sectional view through the fuselage of an aircraft and illustrates how the spray outlet nozzles are arranged within the aircraft cabin.

DESCRIPTION OF PREFERRED EMBODIMENTS

During a crash, the aircraft fuselage may sustain severe damage and may separate into several discrete sections.

In order to improve the prospect that an on-board water spray system would still be effective, even in the event of fuselage break-up, the system may consist of a number of independent sub-systems, each being associated with a respective section of the fuselage, each section typically containing 20 to 30 seats.

Figure 1 of the drawings gives a schematic representation of one such sub-system. This comprises a water supply tank 1 which is connected, via a supply main 2, to several branch pipes 4 arranged at intervals along the fuselage.

Upon activation of the sub-system, the supply tank is pressurised with air from an air pressure bottle 5, causing water to be discharged to the interior of the cabin via a respective set of spray outlet nozzles, e.g. 6, 6", 6"', connected to each branch pipe 4. The form of the spray outlet nozzles, and their location within the cabin, will be described hereinafter with reference to Figure 5.

It will be appreciated that other (inert) gases, for example nitrogen gas, could be used instead of air to pressurise tank 1. Moreover, the gas need not necessarily be supplied from a pressure bottle. Alternatively, a pyrotechnic gas source could be used. A pyrotechnic gas source has the advantage that gas is generated only when it is needed and so gas leakages are eliminated. Furthermore, the pyrotechnic source may be arranged to burn in a controlled manner, tailored to maintain a constant pressure in the ullage reservoir of the supply tank thereby providing a uniform flow of water to the outlet nozzles throughout the discharge.

The pyrotechnic material might typically comprise a pyrotechnic material such as an alkali metal azide (e.g. sodium azide) and an oxidizing agent (e.g. an alkali metal chlorate or perchlorate).

The source of pressurised gas is connected to the tank by means of a suitable control valve 7 (e.g. a solenoid valve) which is effective to release gas into the tank in response to a control signal I_o received from a central control unit 8 for the sub-system. Similarly, a pyrotechnic gas source would have a pyrotechnic igniter which would be activated in response to the control signal I_o. The central control unit 8 receives input signals from several different sources. One of the input signals I_s is produced by one or more smoke detectors 9 whenever the level of smoke detected within the respective section of cabin exceeds a predetermined threshold. To that end, a smoke detector would normally be located centrally within the cabin, at ceiling level. Another input signal I_g is produced by a so-called "g-force" sensor 10 (which may be common to all the sub-systems) in response to the excessively high loads which occur during a crash. The input signals I_w and I_a are aircraft system signals which denote respectively that the aircraft is in a "wheels-down" mode and is at ground altitude.. The control unit 8 also receives command signals I_f and I_g which are set manually by the flight deck crew and the flight cabin crew respectively.

In order to prevent the spray sub-systems being triggered

inadvertently, they must first be enabled (e.g. during take-off and landing) by the flight deck crew (i.e. I_f high). Having been enabled in this manner, any sub-system may be activated either by the cabin crew (i.e. I_c high), by depression of, for instance, "panic buttons" located at strategic positions around the respective section of cabin or by an output from a respective smoke detector 9 indicating a high level of smoke in the associated cabin section (i.e. I_s high).

In the event that the "g-force" sensor 10 detects a high load (I_g high), each sub-system would be enabled automatically (independently of the action of the flight crew) and, as before, could then be activated in response to an output from a smoke detector 9, or by the action of cabin crew.

Since the water spray system is intended to operate when the aircraft is on the ground, the control signal I_o may be inhibited unless the "wheels-down" input signal I_w and the altitude signal I_a have been received.

As an additional measure, the flight crew has the ability to over-ride the control unit 8 and thereby activate the water spray sub-systems directly.

In the event that an enabled sub-system is activated inadvertently, the respective supply tank 1 can be vented externally in order to minimise damage to the cabin. To that end, each tank may be fitted with an active vent 11, such as a dump valve, for example.

Figure 2 shows one embodiment of a dump valve. The valve comprises a valve housing 20 fitted with a sealing piston 21 which is maintained in the closed position (shown on the left side of the drawing) by a ball lock 22 which is held in the locked condition by an actuator piston 23. When it is desired to vent water in the supply tank, an explosive cartridge 24 is triggered by a suitable control signal, produced by the control unit 8 or directly by the crew, forcing the actuator piston 23 downwards thereby rapidly releasing the ball lock from the locked condition. The pressure of water on the upstream side of the valve then forces the sealing piston 21 upwardly in the direction of arrow A (to the position shown on the right side of the drawing) so that the water in the supply tank is discharged via outlet openings 25.

A pressurised, on-board system, as described, would typically discharge water to the cabin at a pressure of about 1 to 7 bar (preferably 2 to 5 bar), and each sub-system would have a sufficient capacity to operate at

this pressure for at least three minutes, by which time a fire appliance would have arrived at the scene.

The water supply system of the tender must be coupled to the on-board system of the aircraft without delay.

Hitherto, external connectors have been provided for this purpose at different connection sites around the aircraft. However, such external connectors can be difficult to manipulate at high speed and, depending on the attitude of the aircraft, are sometimes inaccessible. In addition, damage may have caused the single water main to be damaged or to fracture. As shown in Figure 3, in order to alleviate these short comings, a lance 30, attached to a flexible hose 31, connected to a supply main 32 of the tender, is fired by a pneumatic gun (not shown) into the skin of the aircraft whereby to penetrate the (double) wall 33 of the on-board supply tank 1. By this means the lance establishes a connection between the on-board system and the tender supply system via the flexible hose 31. To assist location of the lance, a marking (in effect a "bullseye") is provided on the exterior surface of the aircraft fuselage to indicate the position of the supply tank within.

In the illustrated embodiment the lance has a barb 34

which is biased by the action of a spring 35 against the inner wall of the tank thereby to establish a fluid-tight seal around the penetration opening formed by the lance tip.

Alternative sealing means can be envisaged. In particular, the inner wall of the supply tank 1 may be made from a self-sealing material which swells up when wet to form a seal around the penetration hole.

The water supply system provided by the tender operates at a much higher pressure than does the on-board water spray system. In order to accommodate these different pressures the spray outlet nozzles of the on-board system may be adapted to operate in two different flow modes; a "low flow" mode, which is adopted when water is being supplied by the (low pressure - typically from 2 to 7 bar) on-board system and a "high flow" mode, which is adopted when water is being supplied by the (high pressure - typically from 7 to 15 bar) tender supply system.

Furthermore, the outlet nozzles should permit routine pneumatic testing in order to confirm the integrity of the pipe-work system, and such testing should be carried out without releasing water from the system.

To that end, each nozzle is sealed to a low pressure, perhaps a few tenths of a bar, which is high enough to enable pressure testing to be carried out, yet is sufficiently less than the "low flow" mode supply pressure. With this in mind, each nozzle is capable of operating in each of three distinct modes; that is, a sealed mode, enabling pressure testing to be carried out up to a first predetermined threshold pressure, a low flow mode operable in response to a water supply pressure which exceeds the first predetermined threshold pressure, but is less than a second predetermined threshold pressure, and a high flow mode operable in response to a water pressure which exceeds the second predetermined threshold pressure.

A nozzle, thus described, may incorporate a switchable valve which interconnects the nozzle inlet and the nozzle outlet, enabling the nozzle to switch between the sealed, low flow and high flow modes in response to a respective pressure change at the nozzle inlet. The valve may respond directly to a change of pressure at the nozzle outlet or, alternatively, may switch between the three modes in response to an output from a pressure transducer arranged to monitor the pressure at the nozzle inlet.

The nozzles should present a neat, unobtrusive appearance

to the interior of the cabin. To that end, each outlet nozzle is fitted with a trim panel and this is arranged to be ejected from the nozzle by the increase of pressure which takes place when the nozzle switches from the sealed mode to the low flow mode.

The ejection of the trim panel may be the means for switching from the sealed mode to the low flow mode.

Figure 4 shows one embodiment of a switchable spray outlet nozzle.

Referring to the drawing, the nozzle comprises a cylindrical nozzle body 40 having an inlet 41 and a spray outlet orifice 42 provided in an end wall 43 of the nozzle body. A trim panel 44 is fitted over the end of the nozzle body, as shown, and is sealed thereto by an "O"-ring 45. Provided the pressure of water at the inlet does not exceed a first predetermined pressure, typically a few tenths of a bar, which is adequate to allow pressure testing to be carried out, the trim panel is retained in place by the "O"-ring and a flow of water is prevented - the sealed mode.

If the pressure at the inlet exceeds the first predetermined pressure, the trim panel 44 will be ejected

allowing water to flow around a cylindrical valve member 46 and to exit the outlet orifice 42 as a spray. The valve member 46 has a helical, ribbed formation 47 which induces swirling as the water flows toward the outlet orifice creating a spray in the form of a hollow cone.

The valve member is supported within the nozzle body by a circumferentially apertured support member 48. To that end, the valve member has an axial shaft 49 located in a cylindrical socket 50 of the support member. A volume 51 of oil trapped at the closed end of the socket contains a gas bubble 52. If the pressure of water is less than a second predetermined pressure, but greater than the first predetermined pressure, the axial position of the valve member 46 in the nozzle body 40 is such that a restrictor 53, in the form of a pip at the end of the valve member, partially blocks the outlet orifice (as shown in the drawing) and so restricts the flow of water - the low flow mode. However, if the inlet pressure exceeds the second predetermined pressure, the pressure of water acting on the valve member compresses the gas bubble 52 thereby displacing the valve member towards the inlet and retracting the restrictor from the outlet orifice, allowing a greater flow of water - the high flow mode.

For a given mode of operation (low or high flow) the

water flow rate and the size of the water droplets in the spray will be determined by the dimensions of the nozzle outlet orifice.

The passenger cabin of an aircraft would be fitted with a large number of spray outlet nozzles and these may have a range of different orifice sizes. The size of orifice selected in a particular case would depend on the location of the nozzle within the cabin. For example, a nozzle positioned in relatively close proximity to combustible material, e.g. below the overhead luggage compartments, would have a relatively large outlet orifice giving a corresponding high flow rate and producing spray containing relatively large water droplets.

Combustion products generated during a fire inside the cabin of an aircraft include toxic gases, such as carbon monoxide, hydrogen fluoride, hydrogen chloride and hydrogen cyanide.

As illustrated in Figure 5 of the drawings, these combustion gases, being buoyant, tend to congregate in an upper region U of the cabin, in the space generally between the overhead luggage compartments L, positioned along, and to either side of, the cabin.

Hithertoknown water spray systems used in aircraft, suffer from the short-coming that the water spray produced in the event of a fire fails to absorb, to a satisfactory extent, the combustion gases which congregate in region U. Over time, the concentration of gas in region U increases, and the gases tend to spread into the main body M of the cabin where they present a hazard to passengers and crew.

With a view to alleviating this short-coming, a further aspect of the present invention provides a water spray system for use in an aircraft in which a plurality of spray outlet nozzles are arranged to direct the spray whereby to enhance the residence time of water droplets in the upper region of the aircraft cabin.

To that end, the nozzles may be so arranged as to direct the spray laterally and/or upwardly.

In a particular configuration, nozzles are mounted to either side of the cabin centre line and, in the case of the cabin having more than one aisle, nozzles may be mounted to either side of each aisle.

The nozzles (e.g. N1,N2) may be mounted directly on the structure of the luggage compartments themselves.

However, the compartments could collapse during a crash landing and so it is preferred that the nozzles (e.g. N3,N4) be mounted on the airframe, preferably in the corner spaces defined by the roof panel R of the cabin and the inwardly facing sides of the overhead lockers on opposite sides of the aisle.

Additional nozzles (N5,N6) may also be provided, at a lower level, in order to douse the furnishings and passengers in the immediate vicinity.

The spray produced by the aforementioned configuration of nozzles resides in the upper region U for a time sufficient to permit enhanced absorption of the combustion gases, thereby significantly reducing the risk to passengers below, and at the same time reducing the quantity of water required.

In order to enhance absorption of carbon monoxide the water may contain a suitable additive. The additive may also be used as an anti-freeze. Alternatively, the supply tank could be fitted with a low energy immersion heater.

It will be appreciated that the described water spray systems are given by way of example only, and it will be

understood that although the described water spray systems are intended for use in aircraft, the invention has a wider, more general, applicability.

CLAIMS

1. A water spray system comprising a water storage vessel, at least one spray outlet nozzle connected to the water storage vessel and a pyrotechnic gas source for pressurizing the water storage vessel enabling water in the vessel to be discharged via the at least one spray outlet nozzle.

2. A water spray system as claimed in claim 1, wherein the pyrotechnic gas source comprises a pyrotechnic composition and means for igniting the composition.

3. A water spray system as claimed in claim 2, wherein the pyrotechnic material is an alkali metal azide (e.g. sodium azide) and an oxidizing agent.

4. A water spray system as claimed in any one of claims 1 to 3 comprising a plurality of water spray sub-systems each comprising a said water storage vessel, a said spray outlet nozzle or nozzles and a said pyrotechnic gas source, and each sub-system being operable independently of the others to supply spray to a respective zone.

5. A water spray system as claimed in claim 4, wherein each zone is a respective zone of an aircraft cabin.

6. A water spray system as claimed in any one of claims 1 to 5, wherein the spray outlet nozzle or nozzles so direct the spray as to enhance the residence time of water droplets in the spray in an upper region of the or the respective zones.

7. A water spray system as claimed in claim 6, wherein the spray outlet nozzle or nozzles are directed upwardly and/or laterally.

8. A water spray system as claimed in any one of claims 1 to 6, wherein the spray outlet nozzle or nozzles are operable in each of three distinct modes; a sealed mode, enabling pressure testing to be carried out up to a first predetermined pressure, a low flow mode operable in response to a water supply pressure exceeding the first predetermined pressure, but less than a second predetermined pressure, and a high flow mode operable in response to a water supply pressure exceeding the second predetermined pressure.

9. A water spray system as claimed in claim 8, wherein the or each nozzle has an inlet, an outlet and a

switchable valve means operable to enable the nozzle to switch between the sealed, low flow and high flow modes in response to a respective change of the supply pressure.

10. A water spray system as claimed in any one of claims 1 to 9, wherein the pyrotechnic gas source is actuated in response to a control signal and including processing means for generating the control signal in response to input signals derived from different respective sources.

11. A water spray system as claimed in claim 10 for use in the cabin of an aircraft wherein said sources are selected from the group consisting of at least one smoke detector, at least one gravity sensor for detecting impact of the aircraft with the ground, a wheels-down sensor, an altitude sensor for detecting when the aircraft is at ground altitude and at least one manually-operable alarm.

12. A water spray system as claimed in claim 11, wherein the processing means inhibits the control signal unless inputs are received from the wheels-down sensor and the altitude sensor.

13. A water spray system as claimed in any one of claims 11 or 12 including means enabling the flight crew to override the processing means.

14. A water spray system as claimed in any one of claims 1 to 13, wherein a wall of the water storage vessel is adapted to be penetrated thereby enabling the interior of the vessel to be connected to an external water supply system via the penetration hole formed in the wall.

15. A water spray system as claimed in any one of claims 1 to 14, wherein the water storage vessel has an exhaust valve operable to vent water stored in the water storage vessel.

16. A water spray system comprising a water storage vessel, at least one spray outlet nozzle connected to the water storage vessel, means responsive to a control signal for pressurizing the water storage vessel enabling water stored in the vessel to be discharged via the at least one spray outlet nozzle and processing means for generating the control signal in response to input signals derived from different respective sources.

17. A water spray system as claimed in claim 16 for use

in the cabin of an aircraft wherein said sources are selected from the group consisting of at least one smoke detector, at least one gravity sensor for detecting impact of the aircraft with the ground, a wheels-down sensor, an altitude sensor for sensing when the aircraft is at ground altitude and at least one manually-operable alarm.

18. A water spray system as claimed in claim 17, wherein the processing means inhibits the control signal unless inputs are received from the wheels-down sensor and/or the altitude sensor.

19. A water spray system as claimed in claim 17 or claim 18, including means enabling the flight crew to override the processing means.

20. A water spray system as claimed in any one of claims 17 to 19, comprising a plurality of water-spray sub-systems each comprising said water storage vessel, said spray outlet nozzle or nozzles, said pressurizing means and a said processing means, wherein each sub-system is operable independently of the others to supply spray to a respective zone of the aircraft cabin.

21. A water spray system as claimed in claim 20,

wherein the gravity sensor and the wheels-down sensor are common to all the sub-systems.

22. A water spray system as claimed in claim 20 or claim 21, wherein the spray nozzles so direct the spray as to enhance the residence time of the water droplets in the spray in an upper region of the respective zones.

23. A water spray system as claimed in claim 22, wherein the spray outlet nozzles are directed upwardly and/or laterally.

24. A water spray system comprising a water storage vessel, at least one spray outlet nozzle connected to the water storage vessel, means for pressurizing the water storage vessel enabling water stored in the vessel to be discharged via the at least one spray outlet nozzle and an exhaust valve operable to vent the water stored in the vessel.

25. A water spray system as claimed in claim 24, wherein the exhaust valve comprises a valve housing defining a passageway extending between an inlet, coupled to the storage vessel, and an outlet, a valve member displaceable by the pressure of water in the storage vessel from a closed position, in which the valve member

blocks the passageway to an open position in which water in the storage vessel is vented through the outlet, and means for releasably locking the valve member in the closed position.

26. A water spray system as claimed in claim 26, wherein the releasable locking means is an explosively actuated ball lock.

27. A water spray system comprising a water storage vessel, at least one spray outlet nozzle connected to the water storage vessel and means for pressurizing the water storage vessel enabling water in the vessel to be discharged via the at least one spray outlet nozzle to a respective zone and wherein the at least one spray outlet nozzle so directs the spray as to enhance the residence time of water droplets in the spray in an upper region of a zone.

28. A water spray system as claimed in claim 27, wherein the at least one spray outlet nozzle is directed upwardly and/or laterally.

29. A water spray system as claimed in claim 27 or claim 28, comprising a plurality of water spray sub-systems each comprising a said water storage vessel,

a said spray outlet nozzle or nozzles and a said pressurizing means, wherein each sub-system is operable independently of the others to supply spray to a respective zone.

30. A water spray system as claimed in any one of claims 27 to 29, wherein the or each zone is a zone of an aircraft cabin.

31. A water spray system comprising a plurality of water spray sub-systems each comprising a water storage vessel, at least one spray outlet nozzle connected to the water storage vessel and means for pressurizing the water storage vessel enabling water in the vessel to be discharged via the at least one spray outlet nozzle, wherein each sub-system operates independently of the others to supply spray to a respective zone.

32. A water spray system as claimed in claim 31, wherein each zone is a respective zone of an aircraft cabin.

33. A water spray system as claimed in claim 31 or claim 32, wherein the pressurizing means in each sub-system is actuated by a respective control signal and includes a respective processing means for generating the

control signal in response to input signals derived from different respective sources.

34. A water spray system as claimed in claim 33, wherein at least one of the sources is common to all the sub-systems.

35. A water spray system comprising a water storage vessel, at least one spray outlet nozzle connected to the water storage vessel and means for pressurizing the water storage vessel enabling water stored in the vessel to be discharged via the at least one spray outlet nozzle to a zone, wherein the at least one spray outlet nozzle is operable in each of three distinct modes; a sealed mode, enabling pressure testing to be carried out up to a first predetermined pressure, a low flow mode operable in response to a water supply pressure exceeding the first predetermined pressure, but less than a second predetermined pressure, and a high flow mode operable in response to a water supply pressure exceeding the second predetermined pressure.

36. A water spray system as claimed in claim 35, wherein the or each nozzle has an inlet, an outlet and switchable valve means operable to enable the nozzle to switch between the sealed, low flow and high flow modes

in response to a respective change of the supply pressure.

37. A water spray system as claimed in claim 35 or claim 36, wherein the or each nozzle has a trim panel which is ejected when the nozzle changes from the sealed mode to the low or high flow modes.

38. A water spray system as claimed in claim 37, wherein the trim panel comprises part of the switchable valve means and is ejected in response to a respective change of the supply pressure.

39. A water spray system as claimed in any one of claims 36 to 38, comprising a valve housing having an outlet orifice and wherein the switchable valve means comprises a valve member displaceable in relation to the orifice between first and second positions corresponding to the low and high flow modes respectively.

40. A water spray system as claimed in claim 39, wherein the valve member has an obturator that blocks the orifice to different extents when the valve member is in the first and second positions.

41. A water spray system as claimed in claim 39, wherein the valve member is so configured as to control

the shape of spray exiting the outlet orifice.

42. A water spray system as claimed in claim 41, wherein the valve member has a helical formation for causing swirling of water in the housing whereby to control the shape of the spray.

43. A water spray system as claimed in claim 37, wherein the trim panel is ejected in response to an output from a pressure tranducer arranged to monitor supply pressure at the nozzle inlet.

44. A water spray system as claimed in any one of claims 35 to 43, wherein the at least one nozzle so directs the spray as to enhance the residence time of water droplets in the spray in an upper region of the zone.

45. A water spray system as claimed in claim 44, wherein the spray outlet nozzle is directed upwardly and/or downwardly.

46. A spray outlet nozzle suitable for use in the water spray system as claimed in any one of claims 35 to 45.

47. A method for connecting a water spray system having

a water storage vessel to an external water supply system, including the steps of penetrating a wall of the water storage vessel whereby to simultaneously connect the interior of the vessel to the external supply system via the penetration hole formed in the supply vessel.

48. A method as claimed in claim 47, wherein the wall of the water storage vessel is penetrated by a remotely launched projectile coupled to the water supply system by a flexible hose.

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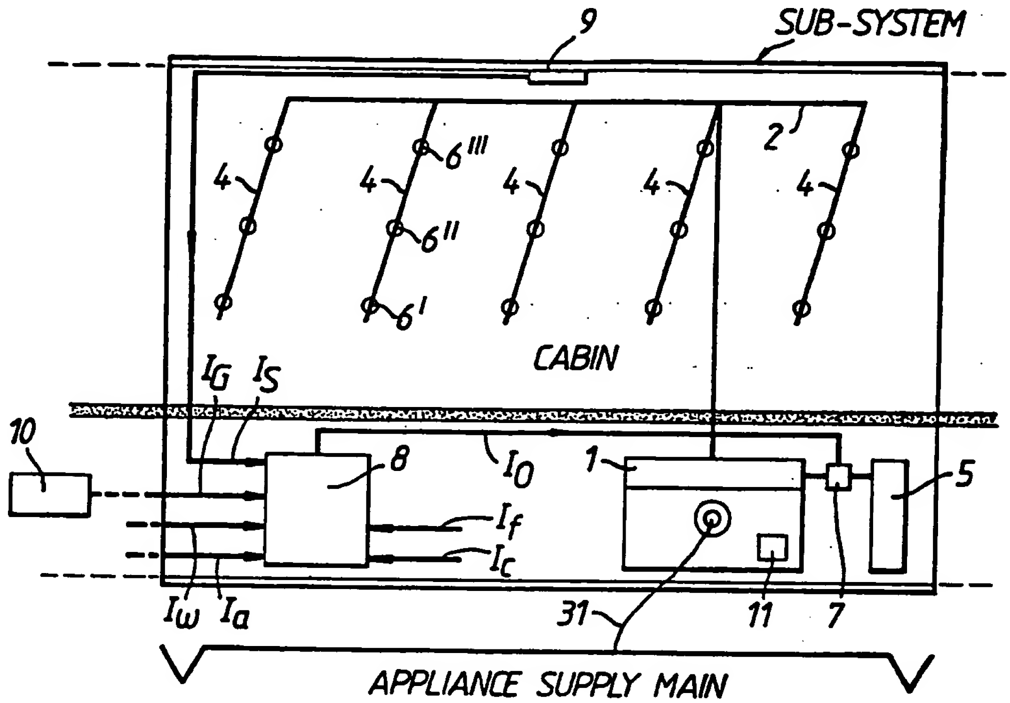

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CABIN
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APPLIANCE SUPPLY MAIN

Fig.1.

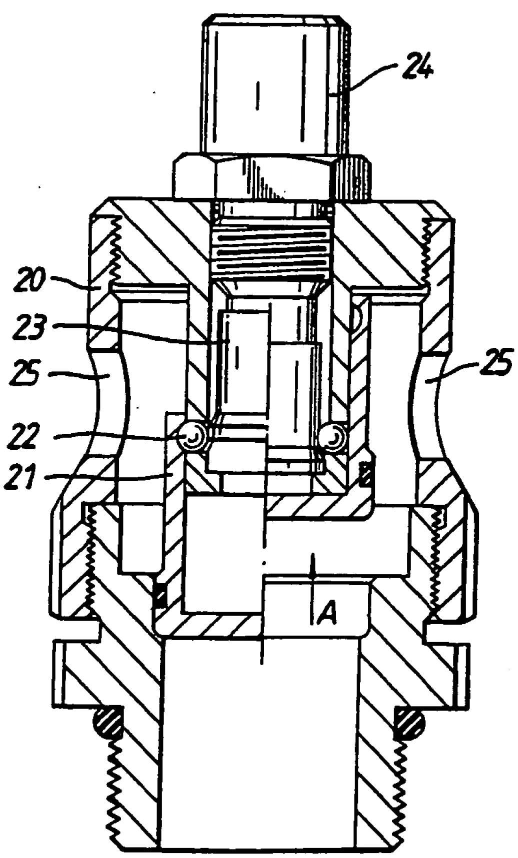

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Fig.2.

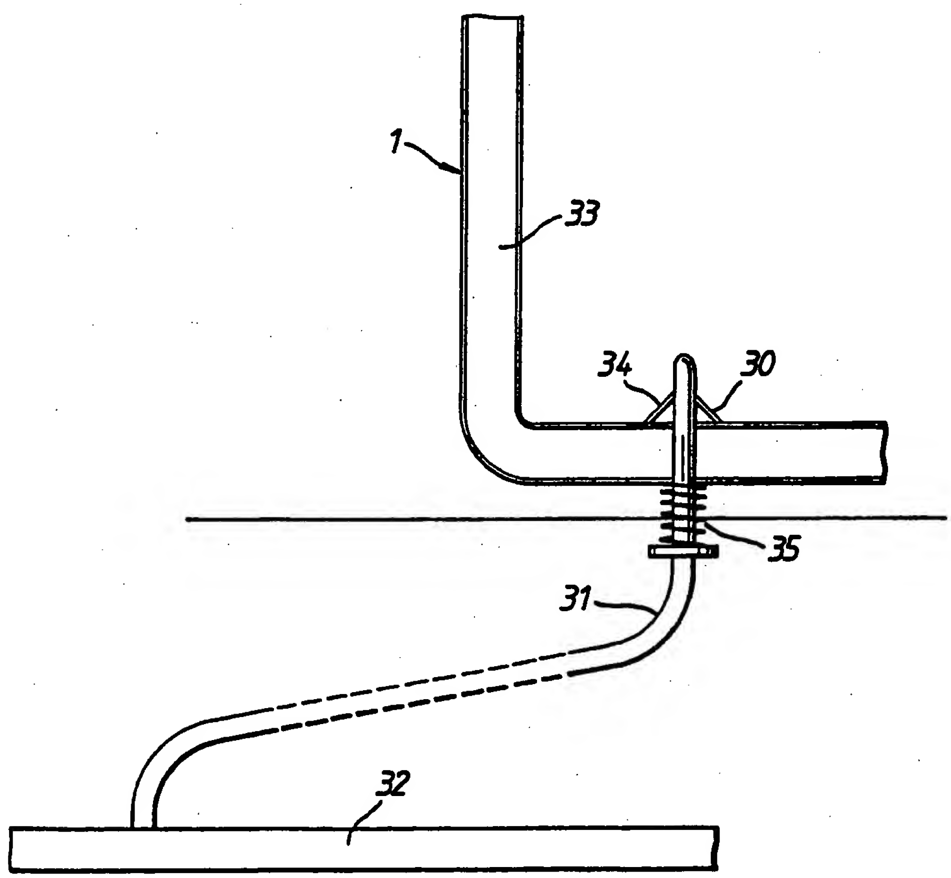

Fig.3.

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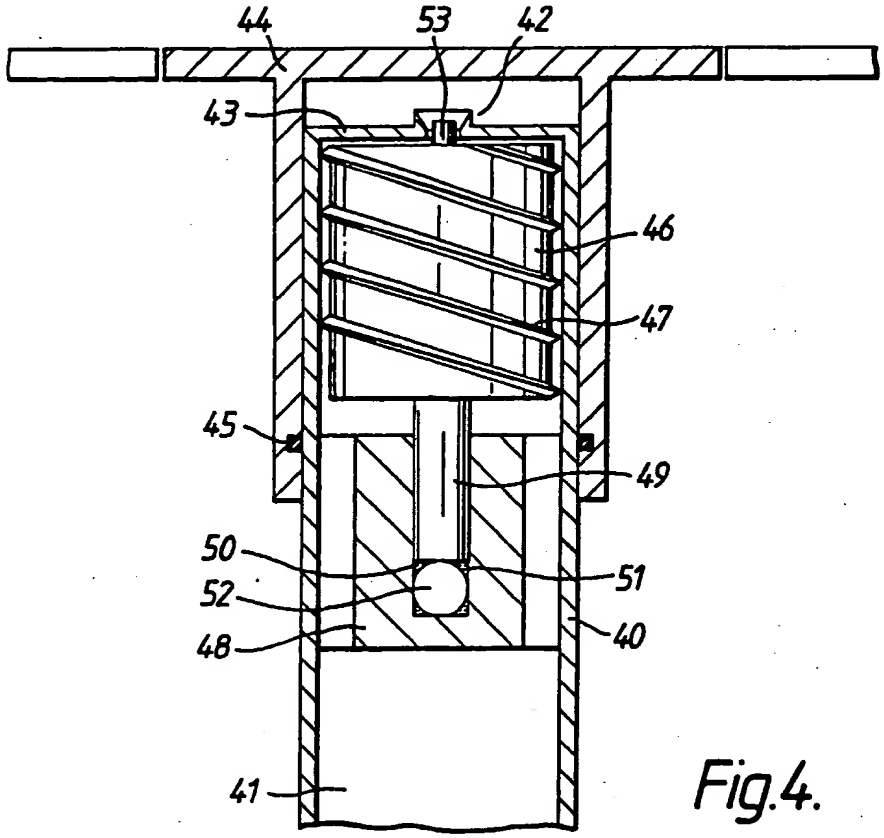

Fig.4.

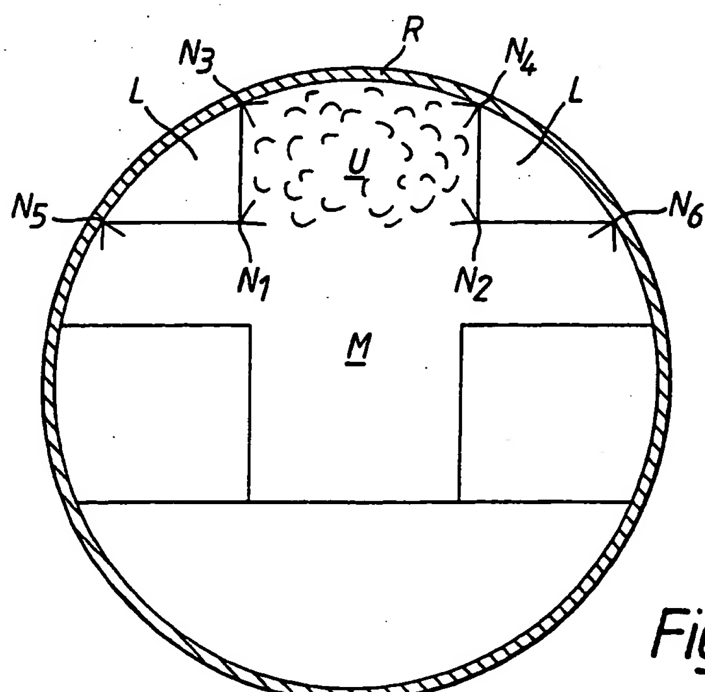

Fig.5